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Monitoring and search for periodic methanol masers

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Abstract. We summarize a long-term monitoring of 11 periodic 6.7 GHz methanol masers and a search for new periodic sources. Observations were carried out with the Torun 32 m telescope. Periods of observed sources range from 29 to 658 days and the data consist of more than 10 observed cycles for most of the masers. Inspection of archival data resulted in identification of 3 new periodic sources while 2 new periodic objects were found in observations started in 2014.

Keywords. masers, techniques: spectroscopic, radio lines: stars, stars: formation

1. Introduction

Recently a small group of 6.7 GHz methanol maser sources that show periodic changes in emission brightness have been discovered (Araya *et al.* 2010, Fujisawa *et al.* 2014, Goedhart *et al.* 2003, Szymczak *et al.* 2015). About 20 periodic sources of different types of behaviour are known. Most of them show periodic changes in the whole spectrum while for a minority of the sources periodicity is seen for individual features. Sinusoidal, asymmetric and intermittent burst profiles are identified.

There is an ongoing debate on periodicity mechanisms and several models have been proposed. In principle, they can be divided into two groups depending on changes in the flux of seed photons or the maser optical path. Periodic variations of methanol masers can be driven by changes in the background radiation flux in a colliding-wind binary (van der Walt *et al.* 2009). The maser optical depth can be modulated by periodic accretion, pulsation of protostar or accretion in a circumbinary disc (Parfenov & Sobolev 2014). Our recent discovery of anti-correlated bursts of the methanol and 22 GHz water maser lines in G107.298 (Szymczak *et al.* 2016) gives strong evidence that change in the pump rate is a plausible cause. Long-time monitoring and search for new periodic sources are necessary to examine these hypotheses. Here, we present a short summary of long-term monitoring and announce the discovery of new periodic masers.

2. Observations and Results

Monitoring program of known periodic masers included 11 targets visible for the Torun 32 m antenna. Additionally, we inspected our archival data for 139 maser sites observed in 2009-2013 and we found 3 periodic maser sources not reported previously.

In 2014 we started a new program focused on finding new sources with periods shorter than 50 days. A total of 121 objects were monitored. Groups of targets were observed on daily basis for approximately 4 weeks and if significant changes in the flux density were detected the observations were continued. The observations of selected groups were repeated after a longer interval. Two new sources with period significantly longer than 50 days were discovered. Considering these results we conclude that sources with short periods are rare.

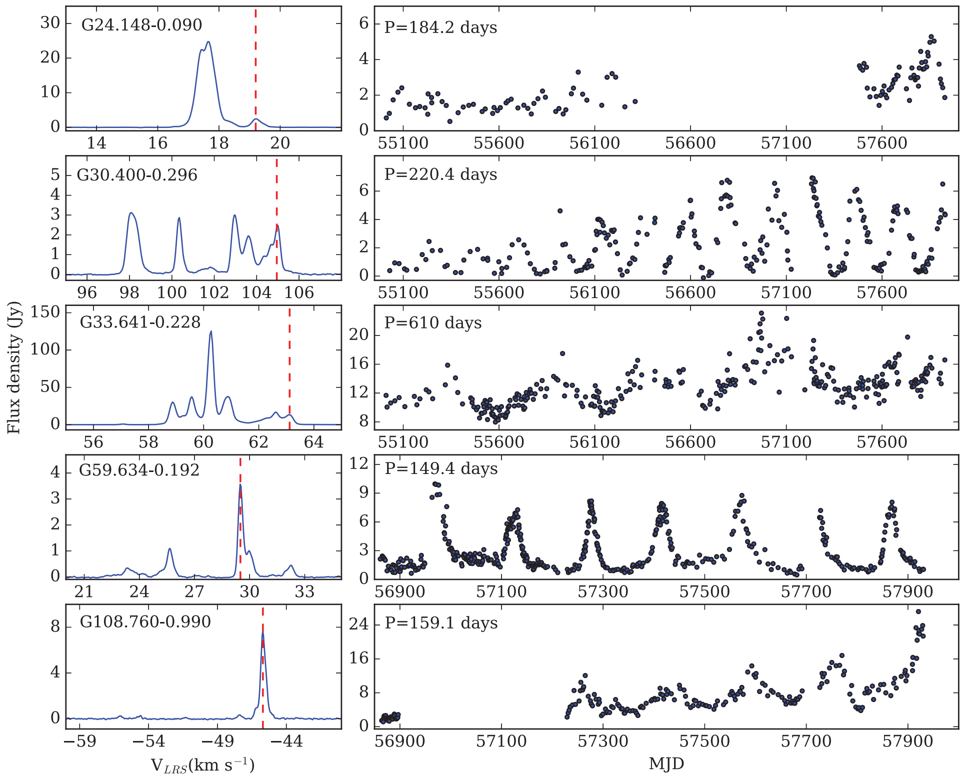

Figure 1. New 6.7 GHz periodic methanol sources. Average spectra are shown on the left and the light-curves of selected features (marked by dashed lines) are shown on the right. For source G30.400−0.296 a periodic behavior is exhibited by spectral features at velocity higher than 104 kms^1. In the other sources the periodic variations are seen in all the spectral features.

Light curves of new periodic sources are shown in Figure 1. Periods of new sources are longer than 149 days. The intensity of most of the objects was relatively weak and for three objects dropped below a sensitivity limit in quiescent state.

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